Pacific NW Testbed

Olympic Peninsula GridWise Demonstration

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GridWise™ Northwest Demonstration Projects

Unleashing the power of distributed resources

Summary of Projects

- **Olympic Peninsula Demand Response Demonstration:**
  - Integrating in-the-field demand response and backup generators in a virtual operating environment
  - Experimenting to relieve transmission and distribution congestion during peak periods.
- **Grid Friendly Appliance Controller Demonstration:**
  - Equipping 150 homes in Washington and Oregon with Grid Friendly appliance controllers on water heaters and clothes dryers.
  - Testing ability to automatically reduce load in response to stress on the grid.

Project Objectives

- Illustrate how the transformed power grid envisioned by GridWise will function and explore key operational issues.
- Demonstrate how transmission and distribution capital investment can be deferred
- Define the role demand response can play in the future
- Reveal how distributed generation can increase system stability and reliability

Who Benefits from GridWise?

Bonneville Power Administration

- Reduce constraints on transmission grid
- Provide ancillary services that increase reliability and minimize outage size and duration.
- Optimize cost-effectiveness by minimizing power purchases and maximizing power sales to regional wholesale market

Local utilities

- Avoid need to expand local capacity by managing peak load on distribution system
- Deliver more reliable power to consumers
- Minimize peak demand charges for power purchased from Bonneville

Consumers

- Avoid increases in electric rates due to avoided transmission and distribution infrastructure investments and savings from optimized system management

GridWise Test Bed Participants

Bonneville Power Administration
Portland Gas and Electric
Mason County Public Utility District #3
Whirlpool
PacifiCorp
Mason County Public Utility District #1
Clallam County Public Utility District

Under discussion: IBM, AREVA T&D

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

Problems Addressed

- Illustrate how the future power grid envisioned by GridWise will function in the next decade
  - Multiple resource types: (Res, Com, Ind) x (DG, DR, Grid Friendly™)
  - Multiple benefits at various levels of the grid
    - generation/wholesale costs
    - transmission congestion
    - distribution asset utilization/avoided capacity expansion
    - ancillary services/stability
  - "Real-time" communication of market-like incentives to obtain voluntary, collaborative response from customers
- Explore key issues associated with that operation

Technical Challenges of Current Practice

- Tangibly defer T & D capital investments
- Managing distribution capacity limits – with certainty
- Multi-level, superimposed market signals
- Interactions of multiple resource & customer types
- Commercial HVAC transactive control paradigm
- Leveraging distributed resources to enhance stability & reliability
- Establishing value for Grid Friendly Appliances
- Benefits involve testing a system, not just one technology

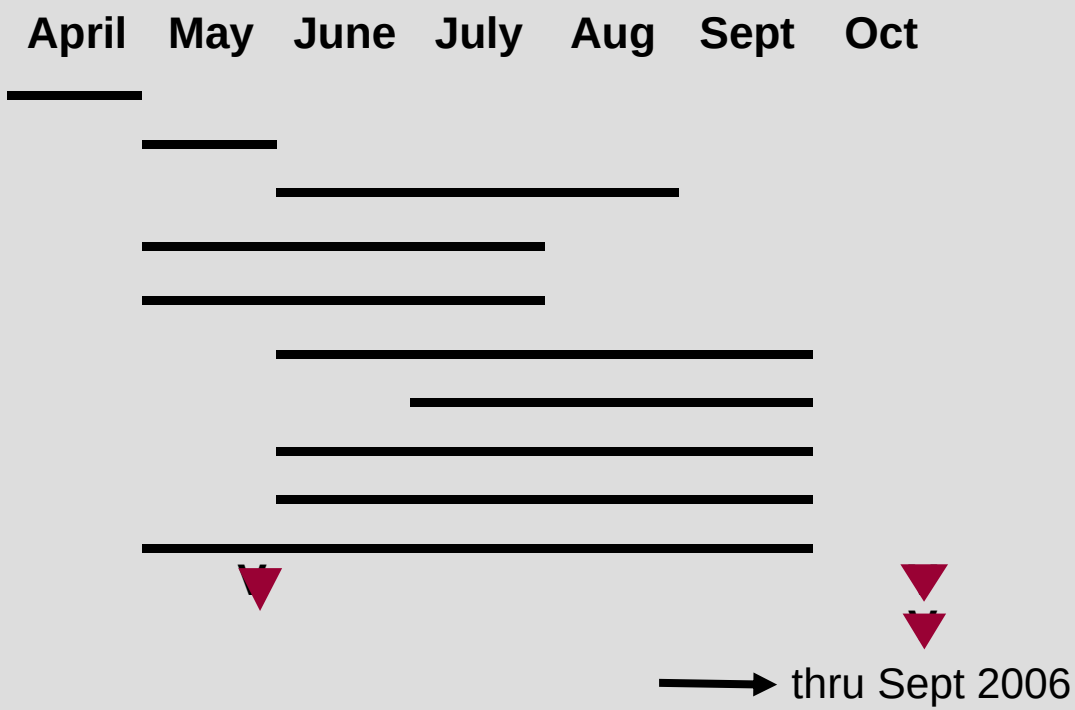
Project Objectives

- Common communications framework & economic dispatch
- Understand how resources perform, individually and when interacting, in near real-time to meet common objectives
- Show how economic structures & social issues influence customer participation & the distributed resources they offer

Technical Approach

- Real, in-the-field, operating distributed resources – both DG & DR
- Leverage resources from Bonneville's *Non-Wires* initiative
- Virtual, near real-time market operating environment
  - backed with real cash consequences to participants
  - provides incentive to operate the resources in collaboration with grid
- Market "experiment" focused on the residential customers. Examples:
  - test consumer response to a real-time pricing scheme and a second scheme such as critical peak pricing
  - test response to the range in price between average and peak demand
- Virtual distribution feeder will be created in software <u>as if the resources involved were literally co-located on a single feeder</u>
- Real-time and historical display of resource operations and costs

Life-Cycle Project Timeline with Milestones and Budget, by FY



Budget $1M

Progress and Accomplishments

- Funding received March 2005
- Scope of work defined & negotiated
- Partners and resources identified
- Kickoff meeting with partners
- Subcontracting process initiated
- Tasks initiated
- Publicity plan being developed
- Recruiting materials being developed

Planned Activities

Virtual Feeder:

- Real assets integrated into a “virtual” distribution environment (0.8 MW Res, 0.3 MW Com, 0.9 MW Ind)
- Appear to perform as resources on a capacity-constrained feeder
- Measured substation feeder loads from SCADA as baseline load
- Manage to arbitrary limit below actual physical capacity
- Shadow market dispatches project resources to limit demand below the level of constraint
- “Virtual” physical environment
  - Commercially-available power systems analysis tools
  - Simulates impacts on power flows, voltages, etc.

Planned Activities (cont.)

- **Market Dispatch Objectives:**
  - Manage actual transmission constraint on the Olympic Peninsula
  - Manage peak load on distribution feeder
  - Provide ancillary services: spinning & non-spinning reserves
  - Reduce cold-load pickup by delaying restart after an outage
  - Min. power purchases and max. power sales to wholesale markets
  - Min. PUD's peak demand charges for power purchased from BPA
- **Market Function:**
  - Compute value for each above, sum to form price for each customer
  - Post current and projected prices on internet (AREVA market software, modified as needed)
  - Communicate current price to each resource's control system
  - Shadow billing system

Impacts and Benefits

- New business models & regulatory solutions targeted at stakeholders such as PUCs – beyond technology demo
- Illustrates much of the breadth and range of GridWise vision
- Shows solutions to problems with broad national applicability
- Helps meet valuable research objectives of GridWise
- Portrays impacts in quasi-real time with a compelling visual interface
- Expandable platform to integrate diverse, geographically-dispersed regional demonstrations, other technologies
- Data collected for further analysis

Interactions & Collaborations

- Bonneville Power Administration – in-kind labor and *Non-Wires* resources
- 3 PUDs engaged: Clallum, Mason #1, Mason #3
- Celerity – DG & water supply system demand response controls
- Residential 2-way demand response & data collection – competitive procurement
- Preston Mitchie (consultant, GridWest RTO) – market structure & basis for prices
- Dr. Lynne Kiesling (the International Foundation for Research in Experimental Economics) – market experiment design
- AREVA T&D – market software as core (in-kind)

Contact Information

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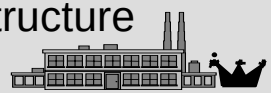
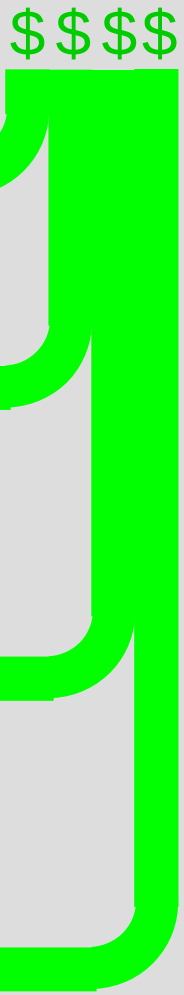
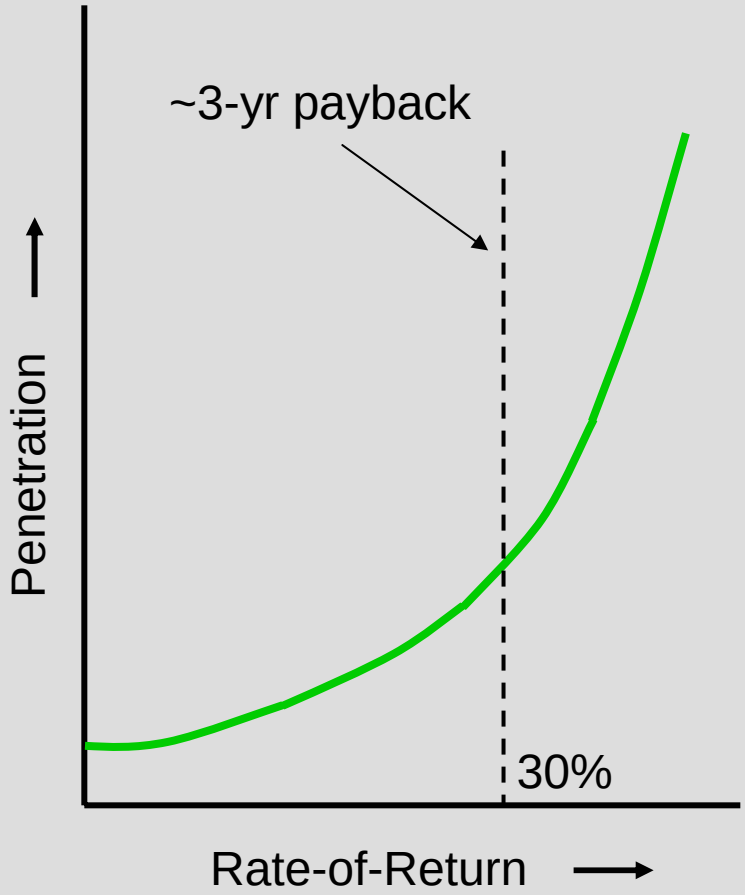
http://www.electricdistribution.ctc.com
http://www.gridwise.org
http://gridwise.pnl.gov

Connecting the Dots of the Value Chain: Revealing Value at All Levels to All Participants

- Central generation
  - Avoided infrastructure
- Transmission
  - Avoided infrastructure
  - Congestion relief
  - VAR support
  - Spinning reserve
  - Non-spinning reserve
- Distribution
  - Avoided infrastructure
  - Voltage support
  - Power quality
- Customer
  - Lower electric costs
  - Waste heat utilization
  - Power quality
  - Backup power

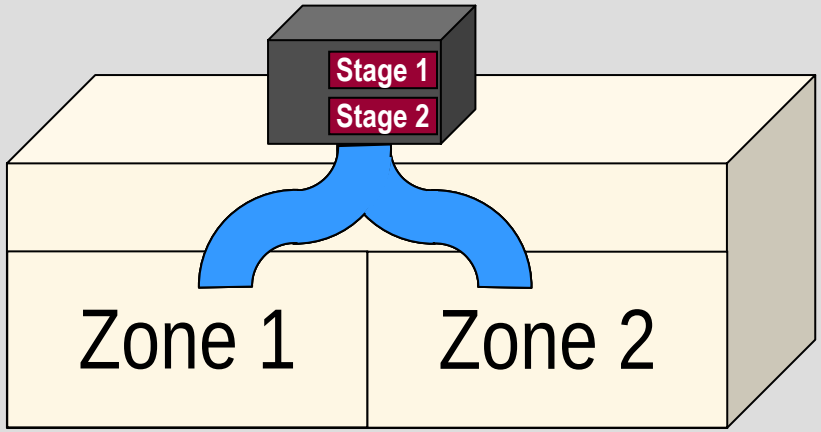


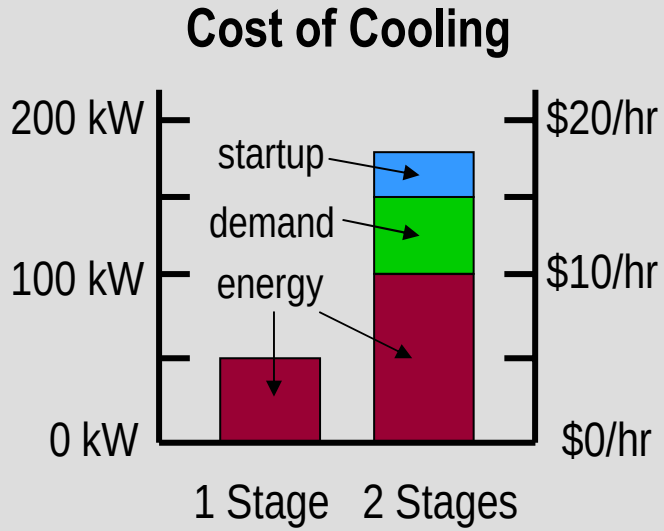




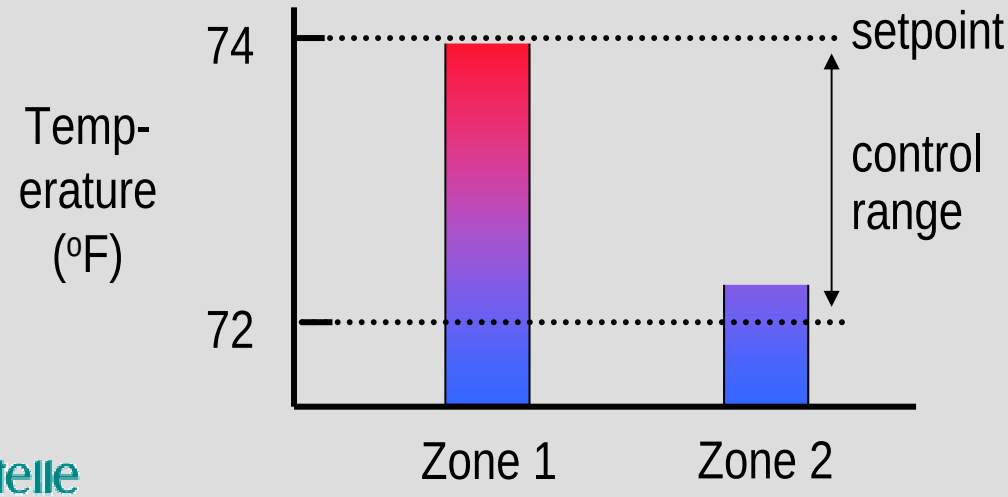
Traditional Control — Satisfies Absolute Demand Regardless of Cost or Grid Conditions

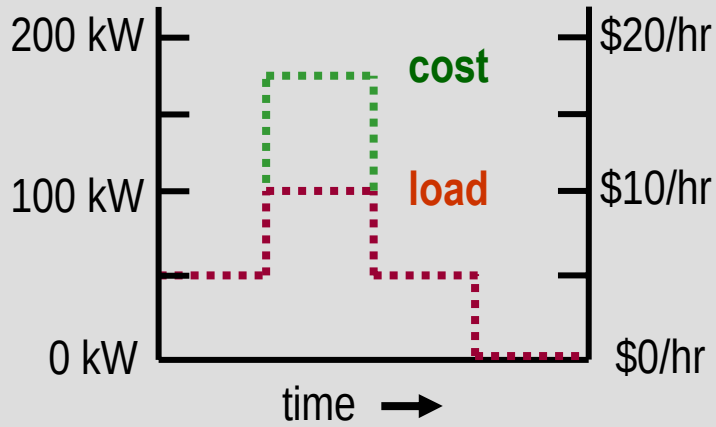
Com-mercial Bldg.



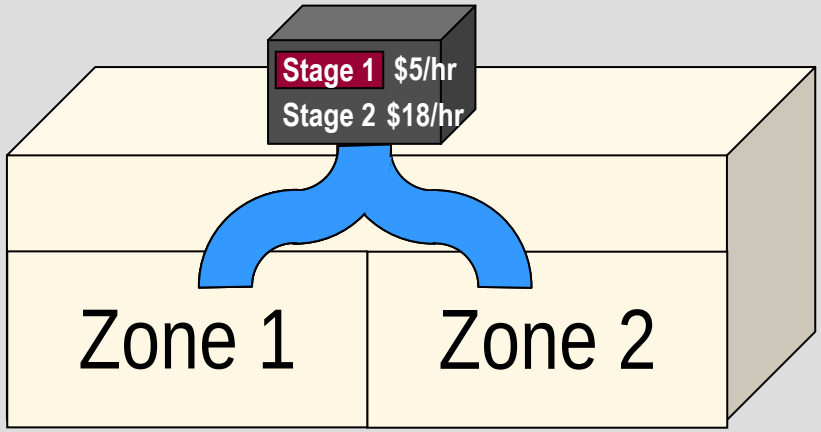


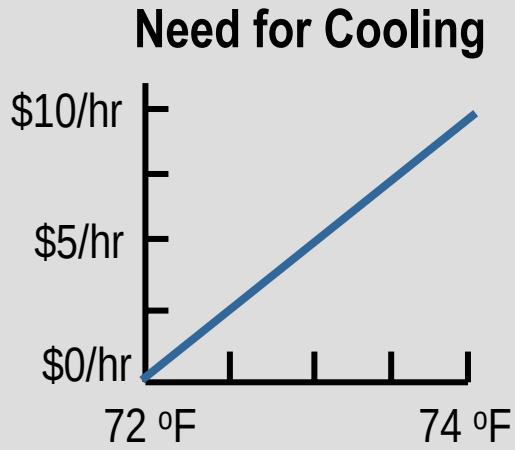
Cooling Demand: **On** **Off**





Transaction-Based Control — Relative Need Expressed as Willingness to Pay; Control System Minimizes Cost





Cooling Need pay up to: **$4/hr** **$8/hr**